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## *Danio quagga*, a new species of striped danio from western Myanmar (Teleostei: Cyprinidae)

Sven O. Kullander\*, Te Yu Liao\* and Fang Fang\*

*Danio quagga*, new species, is described from the Chindwin River drainage near Kalaymyo and Tamu, western Myanmar. It is similar to *D. kyathit* from the Ayeyarwaddy and upper Chindwin River, but differs in having four to five contrasting dark stripes along the side, instead of rows of spots along the side, and shorter barbels. *Danio quagga* is similar in colour pattern to the zebrafish, *D. rerio*, but differs in having four instead of three distinct dark bands above the pectoral fin, and in absence of dark bands on the caudal fin lobes.

### Introduction

The cyprinid fish genus *Danio* includes 13 small species in South and South East Asia. In the most recent overview of the group Fang Kullander (2001) recognized nine species. Since then, we have found that *D. meghalayensis* is a valid species, and subsequent molecular and morphological analyses of danionin interrelationships have shown that *Microrasbora erythromicron* and *Celestichthys margaritatus* must also be referred to *Danio* (Conway et al., 2008; Fang et al., 2009). Sen (2007) described a small danionin species from Meghalaya, India, as *Brachydanio jaintianensis*, which upon revision probably will be confirmed as a species of *Danio*. *Brachydanio* is a junior synonym of *Danio* (Fang Kullander, 2001). Most of the species of *Danio* have a pigment pattern that consists of one or more dark horizontal stripes, which can be homologized between species and

the number and position of which serve as species diagnostic characters (Fang, 1998). One aberrant species, *Danio kyathit*, was described by Fang (1998) from northern Myanmar, differing in having the stripes broken up into rows of small brown spots. Specimens studied by Fang (1998) suggested that there would be variation in the colour pattern of *D. kyathit*. Two preserved specimens from Kamaing and the upper Chindwin basin respectively, appeared identical to other *D. kyathit* except for possessing a pattern of solid stripes or mixed stripes and spots, instead of spots.

We collected recently in the Yu River drainage in western Myanmar, and obtained specimens of *Danio* with a colour pattern consisting of solid horizontal stripes only. The Yu River is a tributary of the Chindwin River, slightly upstream of the Myittha River. Careful comparison with type material of *D. kyathit* from the upper Chindwin and upper Ayeyarwaddy drainages, suggests that

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the Yu specimens represent a species similar to *D. kyathit*, but slightly different in colour pattern and morphology, described below.

### Material and methods

Specimens were fixed in formalin in the field, eventually transferred to 70 % ethanol, and are kept in the fish collection of the Swedish Museum of Natural History, Stockholm (NRM). Comparative material is also deposited in the Academy of Natural Sciences of Philadelphia, Philadelphia (ANSP). Measurements were taken with digital callipers to a precision of 0.1 mm. Counts and measurements were made according to Fang (1997), and colour pattern terminology follows Fang (1998). Horizontal stripes are identified by alphanumeric annotations: the P stripe is the dark stripe along the middle of the side, those above are numbered P+1, P+2, those below P-1, P-2, P-3; stripes on the anal fin are numbered with the middle one the A stripe, the proximal stripe A+1, and the distal stripe A-1. Fin-ray counts from median fins and vertebral counts were obtained from X-radiographs made with a Philips MG-105 low voltage X-ray unit and Kodax X-Omat V plates. Abdominal vertebrae counts include the Weberian apparatus (assumed to contain four centra). Statistics were calculated using SPSS v. 17 (SPSS, 2008). The type series of *Danio kyathit* (NRM 37291, 37292, 37244, and ANSP 93957), and specimens of *D. rerio* from the Brahmaputra (NRM 52658) and Ganga drainages (NRM 40446) were used as comparative material.

### *Danio quagga*, new species

(Fig. 1)

**Holotype.** NRM 58705, 22.2 mm SL; Myanmar: Sagaing Division: Kamphat River drainage (to Yu River): small river in Saw Bwa Ye Shan village, 46 km on road from Kalaymyo to Tamu, 23°37' 14"N 94°7'32"E; S. O. Kullander & T. Y. Liao, 28 Mar 2008.

**Paratypes.** NRM 58787, 2, 26.7-28.9 mm SL; NRM 58725, 2, 34.7-35.3 mm SL; Myanmar: Sagaing Division: Yu River drainage (to Chindwin River): market in Tamu; S. O. Kullander & T. Y. Liao, 29 Mar 2008.

**Diagnosis.** Different from all other species of *Danio* by having four distinct dark stripes (P+1, P, P-1, P-2) along the middle of the side, and also a short or long stripe abdominally (stripe P-3). *Danio kyathit* has a similar horizontal stripe pattern but the stripes are broken up into rows of spots. Rostral barbel short, reaching at most to posterior margin of orbit, vs. reaching to opercle in *D. kyathit*; maxillary barbel reaching to little beyond pectoral-fin base, vs. to middle of pectoral fin in *D. kyathit*. Head (22.8-24.8 % SL vs. 25.3-26.1), pectoral-fin (23.5-25.8 % SL vs. 26.8-29.8) and predorsal lengths (56.1-59.5 % SL vs. 60.6-63.6) shorter, and interorbital width narrower (9.0-10.8 % SL vs. 10.7-12.0) than in *D. kyathit*. Distinguished from *D. rerio*, with similar striped colour pattern, by having four distinct dark stripes above the pectoral fin, vs. three in *D. rerio*; horizontal dark stripes slightly ventrad slanting vs. horizontal; and absence of dark stripes across caudal fin lobes, vs. presence.

**Description.** Measurements and counts were taken from all five available specimens, 22.2-35.3 mm SL (Table 1). The holotype is well preserved but has lost scales and some rays are broken from the caudal and anal fins. The paratypes are in a relatively poor state of preservation, partly with eroded bellies, and scales absent from anterior sides. General body features and pigmentation are illustrated in Figure 1.

Body compressed, moderately elongate. Snout short, rounded, shorter than eye diameter. Mouth terminal, obliquely upwards directed. Small bony knob at dentary symphysis. Maxilla reaching to below anterior margin of orbit; premaxillary ascending processes not reaching to vertical from anterior margin of orbit. Lower jaw projecting beyond upper jaw, ending anteriorly above horizontal through middle of eye. Lower jaw with anterior fleshy lateral lobe beset with small conical tubercles; posterior and median to lateral lobe two close-set rows of small conical tubercles. Maxillary barbel more than double length of rostral barbels, ending distinctly posterior to pectoral-fin base. Rostral barbel reaching to 2/3 of orbit or immediately beyond posterior margin of orbit. Head compressed, slightly deeper than wide.

Squamation incomplete in all specimens due to abrasion. Lateral line abbreviated, with at least one and up to five scales; 28-30 scales in lateral



**Fig. 1.** *Danio quagga*, NRM 58705, holotype, 22.2 mm SL; Myanmar: Sagaing Division: Chindwin River drainage: small stream in Saw Bwa Ye Shan village.

row, counting scale pockets and few remaining scales. Median predorsal scales 15 (2), 16 (3). Body lateral scale rows 5 (5) above lateral line row, 1 (5) below. Circumpeduncular scale rows 10 (5). A row of scales along anal-fin base.

Dorsal-fin rays ii.7 (5); anal-fin rays iii.12 (4), iii.13 (1); pectoral-fin rays i.11 (2), i.12 (2), i.13 (1); pelvic-fin rays i.7 (4); principal caudal-fin rays

10+9 (5). Dorsal fin inserted at highest point of dorsum, at about  $\frac{2}{3}$  distance from head to caudal-fin base, slightly anterior to vertical from anal-fin origin. Pectoral-fin insertion at about vertical through posterior margin of opercle. Pectoral-fin rays long, extending to slightly beyond pelvic-fin origin. Pectoral-fin axial lobe well developed. Pelvic-fin origin situated at about middle of body,

**Table 1.** Morphometry of *Danio quagga*. Measurements are in per cent of SL, except for SL and TL (in mm). SD, standard deviation. Ranges for *D. kyathit* (from Fang, 1998; N=6, except caudal peduncle length was re-measured in four specimens) for comparison. Differences in range of variation indicated in bold.

	<i>D. quagga</i>					<i>D. kyathit</i>
	N	min	max	mean	SD	
SL (mm)	5	22.2	35.3	29.6	5.53	26.9-34.5
TL (mm)	5	28.4	45.2	38.0	7.10	39.3-44.2
Body depth	5	25.2	26.6	25.8	0.57	24.5-29.4
<b>Head length</b>	5	<b>22.8</b>	<b>24.8</b>	<b>23.5</b>	<b>0.85</b>	<b>25.3-26.1</b>
Snout length	5	5.6	6.5	6.1	0.38	6.3-7.6
Head depth	5	15.0	18.3	16.0	1.34	15.8-17.1
Head width	5	11.5	14.0	12.4	0.94	13.4-14.9
Upper jaw length	5	8.4	9.9	9.2	0.65	9.3-10.0
Lower jaw length	5	10.7	12.2	11.4	0.63	11.9-13.3
Orbital diameter	5	6.9	9.0	8.0	0.88	6.5-7.3
<b>Interorbital width</b>	5	<b>9.0</b>	<b>10.8</b>	<b>10.1</b>	<b>0.67</b>	<b>10.7-12.0</b>
Caudal peduncle length	5	17.3	21.1	18.4	1.55	15.8-18.0
Caudal peduncle depth	5	10.8	13.2	12.4	0.99	10.4-14.2
Dorsal-fin base length	5	11.5	13.9	12.5	0.99	12.4-14.2
Anal-fin base length	5	19.8	24.0	21.3	1.69	22.0-23.8
<b>Predorsal length</b>	5	<b>56.1</b>	<b>59.5</b>	<b>58.1</b>	<b>1.41</b>	<b>60.6-63.6</b>
Preanal length	5	63.1	69.9	65.8	2.57	59.5-63.9
Prepelvic length	4	46.8	49.1	48.3	1.03	45.2-49.8
<b>Pectoral-fin length</b>	5	<b>23.5</b>	<b>25.8</b>	<b>25.2</b>	<b>0.97</b>	<b>26.8-29.8</b>
Pelvic-fin length	4	14.4	15.6	15.0	0.55	14.6-16.1
<b>Rostral barbel length</b>	4	<b>9.0</b>	<b>11.2</b>	<b>10.0</b>	<b>0.93</b>	<b>12.0-14.7</b>
Maxillary barbel length	4	21.0	24.8	22.7	1.61	24.2-37.4

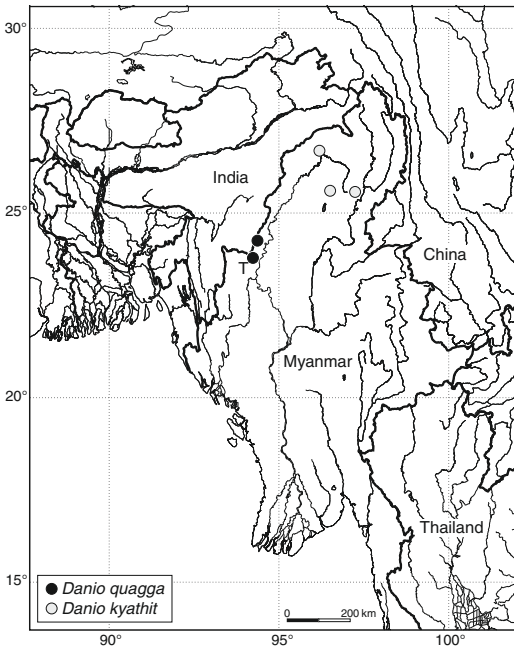


Fig. 2. Location of sampling localities of *Danio quagga* and *D. kyathit* in Myanmar. T, Type locality of *D. quagga*. Localities of *D. kyathit* from Fang (1998).

anterior to dorsal-fin origin; pelvic fin reaching to anal-fin origin. Pelvic axillary scale present. Caudal fin forked, lobes of about equal length.

Vertebrae 15+18(1, holotype), 16+17(4). Tubercles other than those on lower jaw absent in holotype and apparently also absent from paratypes, but latter not well preserved.

**Colouration in preservative.** White ground colour. Dorsal scales sparsely pigmented, brownish distally. Six horizontal dark brown stripes (P+2 through P-3) along side: P+2 stripe narrow and indistinct, from slightly behind head to about vertical from dorsal-fin origin; P+1 stripe distinct, from head, with sharp ventral margin, dorsal margin to some extent confluent with lighter brownish colour on caudal peduncle, extended onto dorsal lobe of caudal fin as dark streak; P stripe distinct, from head, with sharp margins, slightly widening caudally, continued much narrower on upper rays of lower lobe of caudal fin as dark streak; P-1 stripe from pectoral girdle, with sharp margins, slightly less densely pigmented caudally, slightly ventrad directed to run along lower margin of caudal peduncle, continued basally on middle rays of lower lobe of caudal

fin; P-2 stripe from pectoral girdle just above base of pectoral fin, with sharp margins, slightly ventrad directed, running along anal-fin base and merging with A+1 stripe on anal fin; P-3 stripe from pectoral axilla, with sharp margins in large specimens, but only scattered pigment in holotype and 26.7 mm specimen, ending at about vent. Interspaces between dark stripes slightly widening posteriorly due to slight radiating shift in course of stripes. Abdomen white. Head with sparse pigment. A short, narrow band of black pigment on chest just ventral to pectoral-fin base. Caudal fin hyaline, with narrow dark stripes continuing body stripes P+1, P, and P-1. Dorsal fin hyaline, with indistinct dark band across middle of rays, and less distinct band distally. Anal fin with three dark stripes across rays, one distally (stripe A-1), one along middle of fin (stripe A), and one basally (stripe A+1).

**Geographical distribution and habitat.** *Danio quagga* is known with certainty only from the Yu River drainage (Fig. 2). It seems plausible, however, that it has a wider distribution within the Chindwin River drainage which has been subject to very little collecting for fish. The type locality was a very small slow-flowing stream over sandy and stony bottom remaining in the bed of a much larger stream at the height of the low water period (Figure 3). The holotype was collected with a seine in a pool margined with vegetation. Despite extended efforts, only one specimen could be obtained. Four additional specimens were sampled in heaps of small fish offered at the local market in Tamu town, said to be from the nearby river, but we do not have precise information about where they were collected. Sampling in two streams near Tamu did not produce any specimens of *D. quagga*.

Other species obtained at the type locality included another small, abundant species of *Danio*, *Esomus altus*, *Garra* sp., *Puntius meingang-bii*, *P. sophore*, *P. chola*, *Rasbora ornata* (Cyprinidae), *Badis ferrarisi* (Badidae), *Acanthocobitis botia*, *A. rubidipinnis* (Nemacheilidae), and *Lepidocephalichthys berdmorei* (Cobitidae).

**Etymology.** *Equus quagga* is one of the species of zebras, striped members of the family Equidae. *Quagga* is here used as a noun in apposition, and is given with reference to the similarity in colour pattern.





Fig. 3. Type locality of *Danio quagga*: small pool-like widening in small stream in Saw Bwa Ye Shan village, 28 Mar 2008.

### Discussion

*Danio quagga* is similar to *D. rerio* in the conspicuous contrasted pattern of alternating dark and light horizontal stripes (Fig. 4). *Danio rerio* is a widely distributed species in the Ganga, Brahmaputra and Indus basins, and known from a few other localities more south on the Indian peninsula. *Danio quagga* differs from *D. rerio* in details of the colour pattern. In *D. rerio* the horizontal stripes run horizontally and in parallel, where in *D. quagga* stripes P-1, P-2 and P-3 are distinctly slanting, and more separated caudally. In *D. quagga* the P+2 stripe does not show distinctly close to the head, whereas in *D. rerio* it is narrow but with a clear origin on the head above the opercle. In *D. quagga* stripes P+1, P, P-1, and P-2 are narrow close to the head, and widening caudally; stripe P+1 becomes constricted again posteriorly on the caudal peduncle. In *D. rerio*, stripes P+1 and P are of similar width along the length. In *D. quagga* stripe P-1 ends on the lower

margin of the caudal peduncle, whereas in *D. rerio* it has a lateral course all the way. Stripe P-3 is not found in *D. rerio*, and stripe P-2 in that species extends only a short distance anterior to the pelvic-fin base, whereas in *D. quagga* it continues cranially all the way to the pectoral girdle. In *D. rerio*, the two major stripes (P+1, P) originate immediately behind the gill cover, and stripe P-1 at the pectoral axillary flap; by contrast in *D. quagga* stripes P+1, P and P-1 originate in the positions of stripes P+1 and P in *D. rerio*, and stripe P-2 in the position of P-1 in *D. rerio*. *Danio rerio* also has only one dark stripe in the dorsal fin, in a distal position, whereas in *D. quagga* there is an indistinct marking across the middle of the fin rays, and a less distinct dark field distally. In *D. rerio* the caudal fin is strongly patterned with distinct dark stripes extending bars P+1, P, and P-1, and also an additional dark stripe more distally on each caudal-fin lobe which is absent in *D. quagga*.

The horizontal markings of *D. quagga* agree



Fig. 4. *Danio rerio*, NRM 52658, 22.6 mm SL. India, Assam: Brahmaputra River drainage: near Kaupati.



Fig. 5. *Danio kyathit*, paratype 37244, 31.0 mm SL. Myanmar: Kachin State: Ayeyarwaddy River drainage: Hpa Lap stream near Myitkyina.

better with *D. kyathit* than with *D. rerio*, except that in *D. kyathit* the stripes are disrupted into rows of dark spots (Fig. 5). In *D. kyathit* the P stripe may be further subdivided into two parallel rows of spots converging on the caudal peduncle. Otherwise, as in *D. quagga*, the P+1, P, P-1, and P-2 stripes (or rows of spots) originate behind the opercle, and stripe P-2 in the pectoral-fin axilla. Stripe P-1 runs ventral, but still more lateral in *D. kyathit*, and *D. kyathit* also possesses a short row of spots representing stripe P-3. *Danio kyathit* also shares with *D. quagga* an indistinct dark stripe at the base of the pectoral fin, and a dark stripe across the middle of the dorsal fin rays. In both *D. quagga* and *D. kyathit* stripes P+1 and P continue on the caudal fin, and there may also be some pigmentation on the lower lobe posterior to stripe P-1.

The only definite difference in colour pattern between *D. kyathit* and *D. quagga* is that the former is spotted and the latter striped. The only obvious other external difference that we have discovered is in the caudal extension of the barbels. In

*D. quagga* the rostral barbel, when laid back, reaches at most barely beyond the posterior margin of the eye, whereas in *D. kyathit* it reaches to the opercle. This is also reflected in proportional measurements (Table 1), with *D. kyathit* having proportionally longer barbels.

Several proportional measurements of *D. quagga* lie outside of the range reported by Fang for *D. kyathit*, and notably the head, pectoral, and predorsal lengths are shorter, and the interorbital width somewhat narrower (Table 1). We re-measured some of the paratypes of *D. kyathit* to check for differences in methods of measuring, and the differences hold, except that caudal-peduncle length measurements in Fang (1998) are conspicuously smaller (13.1-14.2 % SL), so we re-measured four specimens of *D. kyathit*, from which we obtained caudal peduncle lengths of 15.8, 16.1, 17.1, and 18.0 % of SL, which tends to be shorter than in *D. quagga*, but still overlapping with *D. quagga*. *Danio quagga* has 12 or 13 branched anal-fin rays, averaging lower than *D. kyathit* with 13-14 rays (counts of 16 and 17 in Fang, 1998



should be reduced with three). The vertebral count is the same in the two species, but 16+17 is modal in *D. quagga*, and *D. kyathit* has exclusively 15+18.

The colour pattern of *D. quagga* resembles that of the specimen from Kamaing (in the Ayeyarwaddy drainage, slightly west of Myitkyina) illustrated by Prashad & Mukerji (1929: pl. VII) as *D. rerio*, and referred to *D. kyathit* by Fang (1998). That specimen is shown with very long rostral and maxillary barbels, similar to *D. kyathit*, but unlike *D. quagga*. In spotted *D. kyathit* it can be difficult to trace the orientation of the rows of spots. Generally they run in parallel as in the striped specimen illustrated by Prashad & Mukerji (1929), or the lower stripes make slight curves abdominally. The rows of spots may also be irregular in *D. kyathit*, e.g., when the P stripe is represented by two parallel rows of spots anteriorly (Fig. 5), or when the spots in the P stripe are vertically extended as in the holotype (Fang, 1998: fig. 2). The paratype of *D. kyathit* from the upper Chindwin drainage (ANSP 93957) is faded and the fins are damaged, but there are sufficient remains of the dark pigmentation to see that the P+1, P, and P-1 stripes run in parallel along the side. The P stripe is divided into an upper striped section and a lower spotted section, and the P-1 stripe consists of spots anteriorly. The P-2 and P-3 stripes are slanting as in *D. quagga*.

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# Ichthyological Exploration of Freshwaters

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Cover photograph:

*Danio tinwini* (photograph by Sven O. Kullander)  
Sven O. Kullander and Fang Fang  
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